

Review of U.S. EPA's Diesel Fuel Impact Model: Preliminary Comments

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Outline

- Purpose of the Diesel Fuel Impacts Model (DFIM)
- Concerns with Data Selection Criteria
- Concerns with Model Performance

Purpose of the DFIM

According to EPA, the DFIM is being developed to:

...quantify the emission effects of diesel fuel parameter changes...

because of:

...growing state interest in reducing criteria pollutant emissions by regulating diesel fuel properties...

This requires that the DFIM be an accurate predictor of the emission impacts of changes in Diesel fuel composition. If it is not, then the potential exists for expensive changes in Diesel fuel specifications to lead to little or no reduction in emissions or even increases in certain emissions.

Concerns with Data Selection Criteria Applied to Fuels

- Oxygenated Fuels Should Not Be Included in the Database.
 - Specific oxygenate, not just oxygen content, may be important (SAE2001-01-2019).
 - Relevance of oxygenated fuels to commercial Diesel fuels is not established.
- 2. Engines tested on the transient cycle with No. 1 Diesel or oxygenated fuels should not be remapped from baseline fuel (SAE961981).

Concerns with Data Selection Criteria Applied to Test Cycles

- No explanation is provided regarding the technical basis for using steady-state test results for HC and NO_x, but not PM.
 - Reference cited by EPA (SAE982649) to support appropriateness of including steady-state data for HC and NO_x also supports use of steady-state data for PM.
- Given known relationships between PM, NO_x, and HC emissions from Diesel engines, data for each pollutant should be present for each fuel and test.

Concerns with Data Selection Criteria Applied Based on Engine Technology

1. No explanation is provided regarding the criteria used to determine whether engines that had been “adjusted” from their normal configurations were representative of “engines that had already been sold commercially or had a high probability of being sold in the future.”

Concerns with Representativeness of Test Engines

- Table II.E.3.3-1 of EPA report shows that certain model-year engines are dramatically over-represented relative to 2002 in-use fleet while others are under-represented (e.g., only one 1997-2001 MY engine in database but 1997-2001 engines make up more than 50% of 2002 fleet).
- Reports don't clearly explain fraction of test data from each model-year in the databases used to develop the HC, NOx, and PM models.
- Reports don't clearly explain in terms of Model Year distribution how the 73 engines in Table II.E.3.3-1 compare to the 56 engines used for the HC and NOx models nor the 35 engines used in the PM model.

Concerns With Model Performance

- Inappropriate Comparison of Observed %CE Using Baseline Fuel to Predicted %CE Using Avg Baseline Fuel (page 67 SwRi Report)

Observed % CE =

$$100\% \times [(Fuel\ A)_{AvgObs} - (Baseline\ Fuel)_{AvgObs}] / [(Baseline\ Fuel)_{AvgObs}]$$

where

$(Fuel\ A)_{Obs}$ = average NOx value associated with observations on Fuel A

$(Baseline\ Fuel)_{AvgObs}$ = average NOx value associated with observations on Baseline Fuel

Concerns With Model Performance

(continued)

Similarly, the Predicted % CE would be given by

Predicted % CE =

$$100\% \times [(\text{Fuel A})_{\text{Pred}} - (\text{Avg Baseline Fuel})_{\text{Pred}}] / [(\text{Avg Baseline Fuel})_{\text{Pred}}]$$

where

$(\text{Fuel A})_{\text{Pred}}$ = predicted NOx value associated with Fuel A

$(\text{Avg Baseline Fuel})_{\text{Pred}}$ = predicted NOx value associated with
National Average Baseline Fuel

Concerns With Model Performance

(continued)

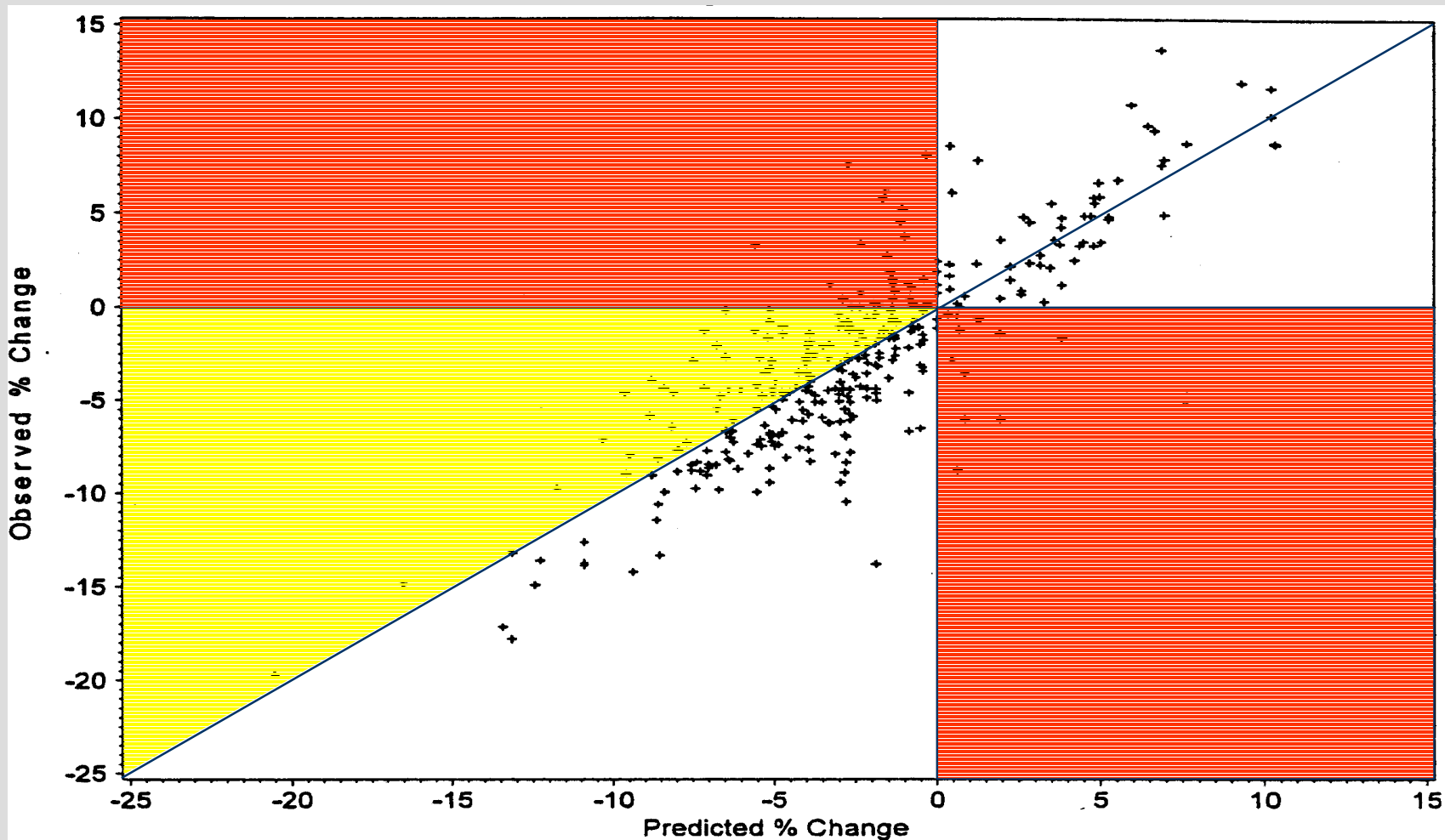
- SwRI report presents comparison of Observed % CE to Predicted % CE
 - Frequency of Predicted % CE that Differ in Sign from Observed % CE – Potential for Increased Rather than Decreased Emissions
 - Overprediction of % CE – Potential for Overestimating Emission Reductions
- Regression analysis of Observed % CE and Predicted % CE should show slope near 1 with good fit
 - **Not Performed**

Concerns With Model Performance

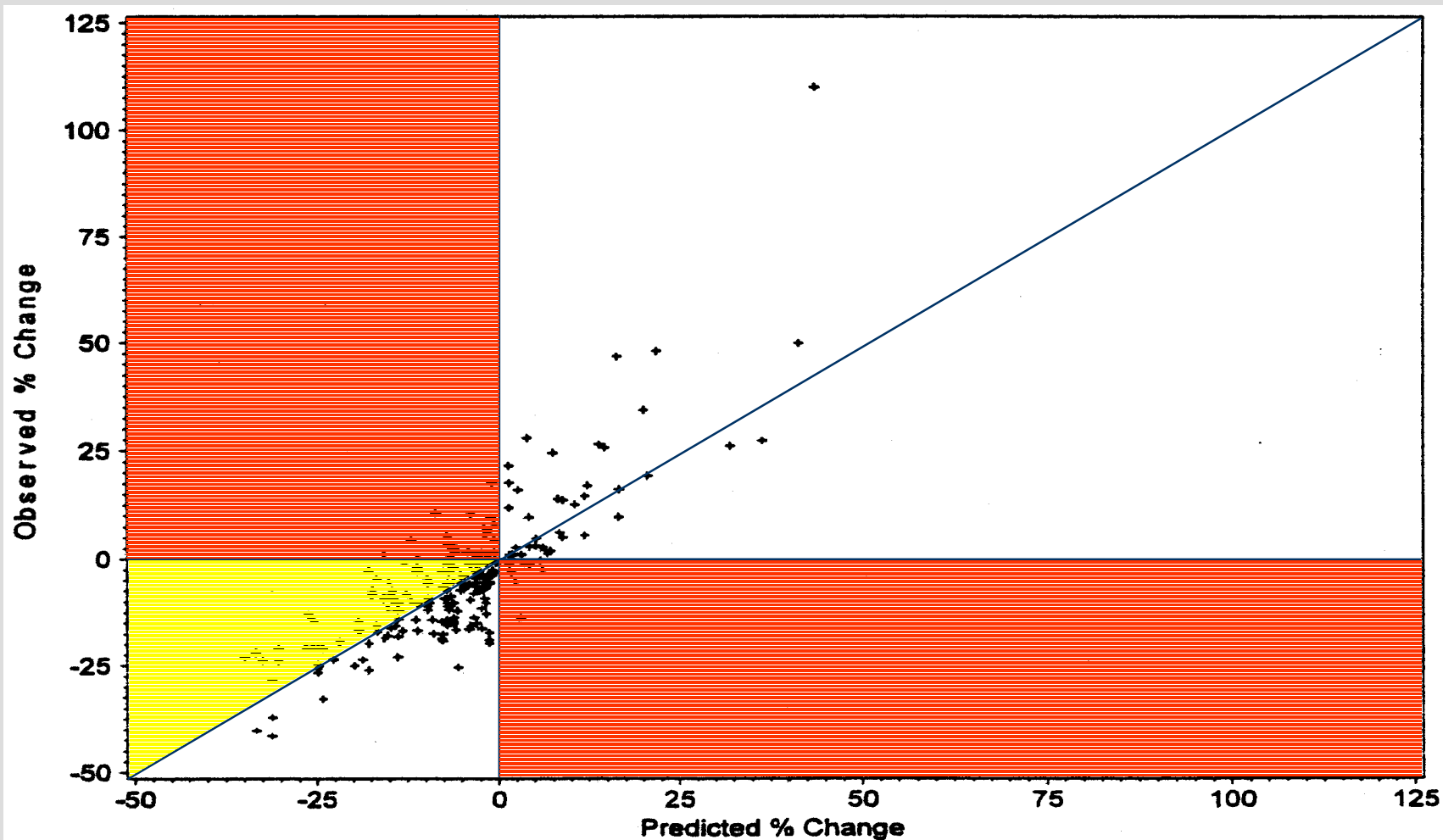
(continued)

- Predictions should agree with observed results for data not included in DFIM database
 - **Not Performed**
- Patterns in pairs of predicted and observed % CE with wrong sign or overprediction of observed emission reductions as a function of study, engine, or fuel should be investigated
 - **Not Performed**

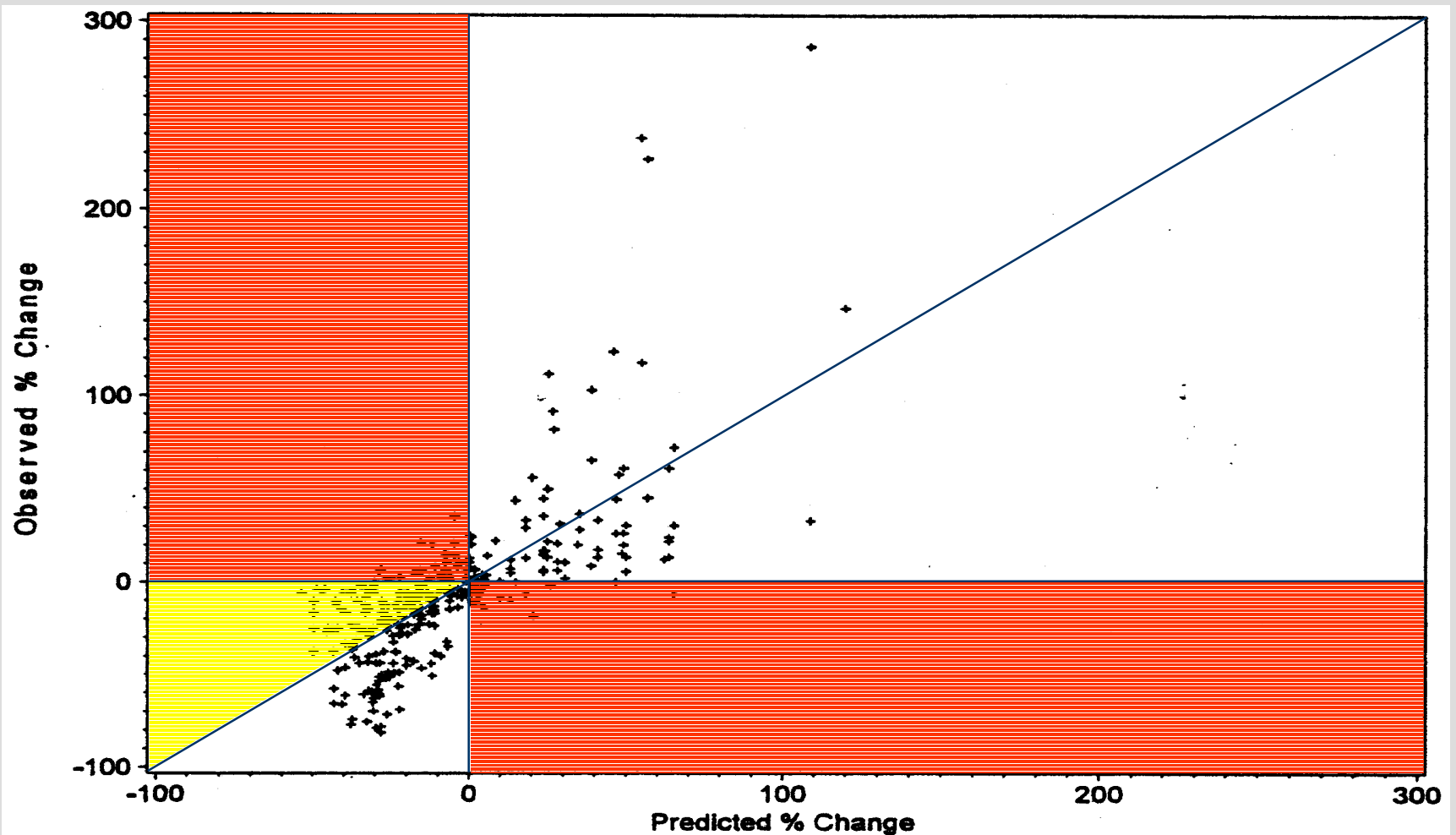
Comparison of Observed & Predicted % Change for NOx



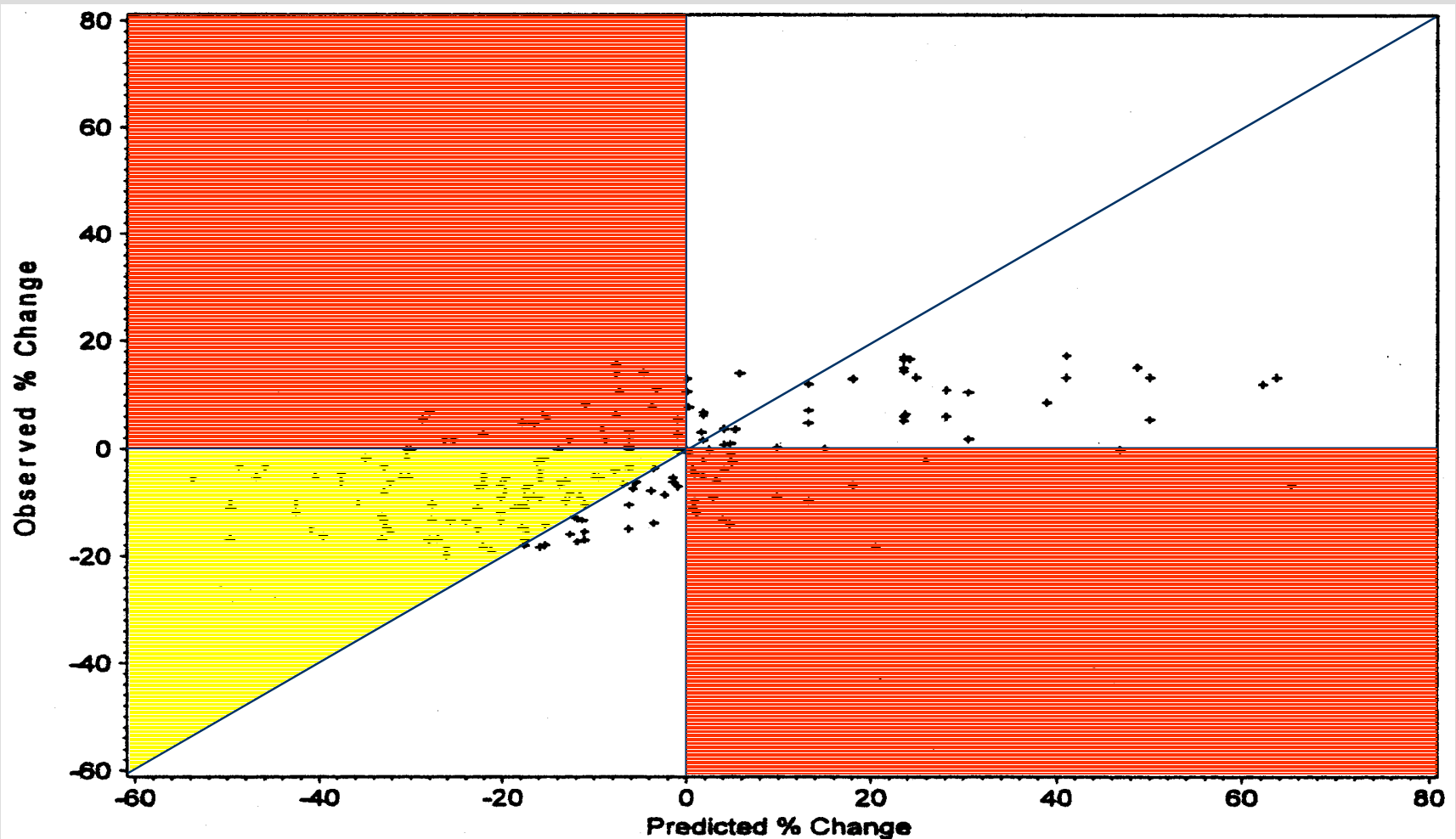
Comparison of Observed & Predicted % Change for PM₁₀



Comparison of Observed & Predicted % Change for HC (Without Restrictions)



Comparison of Observed & Predicted % Change for HC (With Restrictions)



Model Performance

(continued)

Example 1 (SAE 2000-01-1854): EC-D Versus CARB Diesel for Fleet of 12 1995-1998 Model-Year, School Buses, Tankers and Grocery Trucks w/o PM Traps

Comparison of Observed Changes in Emissions for a Small Fleet of Heavy-Duty Diesel Vehicles with DFIM Predictions (Change in Emissions with EC-D Relative to CARB Diesel)

	HC	PM	NOx
Observed	-6.0%	4.7%	-15.2%
Predicted	-6.7%	-14.3%	-7.7%

Model Performance

(continued)

Example 2 (SAE961981): JP-8 with dopant that increases sulfur/cetane in Prototype 1991 DDC Series 60 Engine (T50 of 399F converted to lower model limit of 425F).

**Comparison of Observed Changes in Emissions for
Prototype 1991 DDC Series 60 Engine for JP8 Fuels
Relative to EPA on Highway Diesel**

Pollutant	Change	Base JP8	Fuel A1	Fuel A2
HC	Observed	3.0	17.8	3.4
HC	Predicted	33.6	29.5	18.2
PM	Observed	-22.2	-9.7	4.0
PM	Predicted	-9.9	-6.3	5.5
NOx	Observed	2.1	-1.1	-1.1
NOx	Predicted	-6.1	-6.4	-7.2

Summary

- Concerns with the DFIM Database and Other Factors Make it Difficult if Not Impossible to Develop and Validate Models that Accurately Predict Emission Changes for the In-Use Fleet.
- EPA Has Not Demonstrated that DFIM Performance is Adequate for Regulatory Purposes.
- EPA Should Conduct a New Test Program Designed to Provide Data Needed to Establish and Validate a DFIM.